

HOST RELATIONSHIPS OF *DIABROTICA CRISTATA* (COLEOPTERA: CHRYSOMELIDAE)¹

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ABSTRACT: Observations were made on host relationships of a natural population of *Diabrotica cristata* in pure stands of perennial grasses in eastern South Dakota. The larval host was determined by placing traps to capture adults which might emerge from soil under three species of grass, *Bromus inermis* Leyss (smooth brome grass), *Panicum virgatum* L. (switchgrass) and *Andropogon gerardi* Vitman (big bluestem). Beetles were captured only in traps over big bluestem. Sticky traps were deployed among plants of all three species; significantly more *D. cristata* were captured in plots of big bluestem than in plots of the other two plant species. Sampling the soil for eggs revealed no clear pattern of distribution of eggs among the three grasses, but did establish that *D. cristata* overwinters in the egg stage.

Diabrotica cristata (Harris) is a rather inconspicuous occupant of relict prairie ecosystems east of the Rocky mountains in northern Mexico, the United States, and Canada (Douglas, 1929; Hendrickson, 1929; Smith, 1966). It is a member of the *virgifera* species group along with three pests of corn, *D. barberi* Smith and Lawrence (the northern corn rootworm), *D. virgifera virgifera* LeConte (the western corn rootworm), and *D. virgifera zea* Krysan and Smith (the Mexican corn rootworm). Larvae of *Diabrotica* are known to feed on the roots of plants, and the larvae of the above pest species are known to be oligophagous in that they feed only on the roots of certain grasses (Branson and Krysan, 1981). It has been inferred that *D. cristata* feeds on the roots of perennial grasses in the larval stage because of the host range of the relatives and the fact that adult *D. cristata* are collected in association with native perennial grasses (Smith, 1966; Krysan and Branson, 1981). Furthermore, adult *D. cristata* have been produced in the laboratory from larvae reared on the roots of corn (Branson and Krysan, 1981). Additionally, the adults of the two other species of the *virgifera* group which occur in the United States, *D. lemniscata* LeConte and *D. longicornis* (Say), are also collected in ecosystems characterized by perennial grasses (Krysan, 1982). Grasses may be the primary larval host for this species group.

Our attempts to identify larval hosts of *D. cristata* have been foiled by a

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combination of low larval populations and the complexity of prairie sod; any one spot contains roots of many plant species, which precludes meaningful interpretation of catches in emergence traps placed over such sod and makes larvae, even if one could find them, difficult to associate with the roots of any specific plant. However, in 1982 a large population of adult *D. cristata* was discovered in a nursery of native prairie grasses which included extensive monocultural plots of *Andropogon gerardi* Vitman (big bluestem), and *Panicum virgatum* L. (switch grass), species found in relict prairies. The area also has a monoculture of *Bromis inermis* Leyss (smooth brome grass), an incursive species which is one of the most common grasses of disturbed, untilled, areas of eastern South Dakota. Another plot has a mixture of switch grass and Indian grass (*Sorghastrum nutans* (L.) Nash). For this population of *D. cristata* we determined the overwintering stage, established a larval host and estimated the distribution of adults among the three grass species present.

METHODS

The study area was on the farms of the South Dakota State University Experiment Station at Brookings, SD. The dimensions of the plots used were: big bluestem, 16 by 23 M; switch grass, 20 by 10 M; smooth brome grass, 82 by 82 M.

Soil in plots containing each of the three grass types was sampled for eggs. In September, 1983, three soil samples were taken from each of ten randomly selected plants in the plots of both big bluestem and switch grass and a plot containing a mixture of switch grass and Indian grass. The absence of discrete plants in the brome grass plot required that 30 soil samples be taken randomly. In May of 1984, ten soil samples were taken from each of the three plots. Samples were taken to a depth of 15 cm using the bulb setter method of Howe and Shaw (1972); eggs were separated from the soil by the method of Shaw, et al. (1976), identified to species based on the sculpturing of the chorion (Rowley and Peters, 1972), and counted. A sample of eggs collected in the field in May was incubated in the laboratory at 25°C; hatchlings were fed on the roots of corn and allowed to pupate using the method of McDonald, et al. (1982).

Cages to catch newly emerged beetles were made of plastic screen (1 mm square mesh) and were pyramidal in shape, about 1 m high and 1 m on a side with a plastic skirt about 15 cm wide around the bottom. The skirt was buried in the soil to a depth of about 13 cm. The cages were set out when beetles were first detected using traps baited with a sex attractant (Guss et al., 1983); the dates were July 18 in 1983 and July 12 in 1984. Four cages were placed on randomly selected plants, or areas, of big bluestem, switch

grass, and smooth brome. No cage was closer than 3 meters to the edge of a plot. The grass under each cage was clipped at the time of caging to a height of circa 12 cm. The cages were examined daily from the date of placement until September 1. All emerged beetles were removed and counted.

The relative numbers of beetles present among the three grass species was estimated by use of sticky traps (see Guss, 1983, for a description of the traps). In a preliminary experiment we found that most beetles were captured in sticky traps placed at the height of the grass canopy (Yaro, 1984) so we used that height. As the grass grew during the season, the height of the traps was adjusted. The traps were placed randomly 7 m apart and 2-1/2 m from the edge of the plots, nine traps per grass species.

The data were analyzed by analysis of variance and the means were separated by the Waller Duncan K ratio t test.

RESULTS

The data in Table 1 reveal that eggs of *D. cristata* were present in the fall, after beetles were no longer present, and in the spring, long before any beetles were found. However, there was no definite pattern of distribution of eggs among the various grass species. Some eggs which had passed the winter in the grass plots hatched in the laboratory and ultimately yielded 4 adult *D. cristata*. These data establish that *D. cristata* adults oviposited in these plots and that eggs survived there over the winter.

Of the three species of grass over which emergence cages were placed, adult *D. cristata* were found only in those cages over big bluestem; the mean number of beetles caught per trap was 18, SD 16.6, with a range of 0 to 52 (N = 8). Only one trap had no beetles. We conclude that larvae of *D. cristata* feed on the roots of big bluestem but apparently not on those of switch grass and brome grass, despite the fact that eggs were found among these other grasses.

Table 1. Occurrence of eggs of *D. cristata* among different grass species near Brookings, South Dakota in 1983 and 1984.

Year	Grass species	No. of soil samples	Total eggs	Mean eggs per soil sample	Range
September 1983	Big Bluestem	30	20	0.66	0-19
	Switch Grass	30	12	0.40	0-6
	Switch Grass +				
	Indian Grass	30	91	3.03	0-22
	Brome Grass	30	6	0.20	0-4
May 1984	Big Bluestem	10	59	5.90	0-27
	Switch Grass	10	10	1.00	0-4

The catch of *D. cristata* on sticky traps revealed that in both years significantly more beetles were captured in the big bluestem plots than in the plots of the other two grass species. The mean catches per trap, averaged over all dates, were 6.6 (1983) and 18.9 (1984) in big bluestem, 0.6 (1983) and 1.4 (1984) in switch grass, and 0.1 in both years in brome grass. Compared with that in switch grass and brome grass, the catch in big bluestem was significantly greater at the 0.05 level; the minimum significant differences were 1.62 and 2.82 in 1983 and 1984, respectively. The temporal pattern of catch is summarized in Figure 1. It is clear that adults associated more with big bluestem than the other two grasses.

DISCUSSION

The data establish that *D. cristata* overwinters in the egg stage and is univoltine in South Dakota, as inferred earlier by Krysan (1982). Clearly, *D. cristata* has the same life cycle as its well known relatives, *D. barberi* and *D. virgifera* (Chiang, 1973).

The association of *D. cristata* with big bluestem merits further comment. Adults are generally collected not on grasses but from the succulent flowers of forbs which live among the grasses. This condition prevailed in mixed plots near our study area. However, the plots where sticky traps were placed were completely free of other plants. Thus, the relative trap catch suggests a strong affinity for big bluestem compared with the other two grass species, despite the difficulty in interpreting such trap data on a biological basis. Our observation that big bluestem is a larval host for *D. cristata* does not preclude the possibility that other prairie grasses, or other plants, may serve as a larval host for the insect; indeed, Wiesenborn and Krysan (1980) found *D. cristata* in places where big bluestem was relatively scarce. The key fact is that we now know a larval host and it is a prairie grass, which validates the early speculation on the host of *D. cristata*.

Our observation that eggs of *D. cristata* were present among all three species of grasses, but that larvae apparently fed only on the roots of big bluestem, indicates further study is warranted to establish more clearly the oviposition behavior and larval host range.

For us, a primary reason for studying *D. cristata* is the indirect contribution it can make to our understanding of the host relationships of the pest species in this group; as pests they have been refractory to classical approaches attempting to exploit host plant resistance phenomena so new information concerning host relationships might be useful. The demonstration that big bluestem is a larval host in a natural population of *D. cristata* provides a solid basis for constructing and testing hypotheses on the

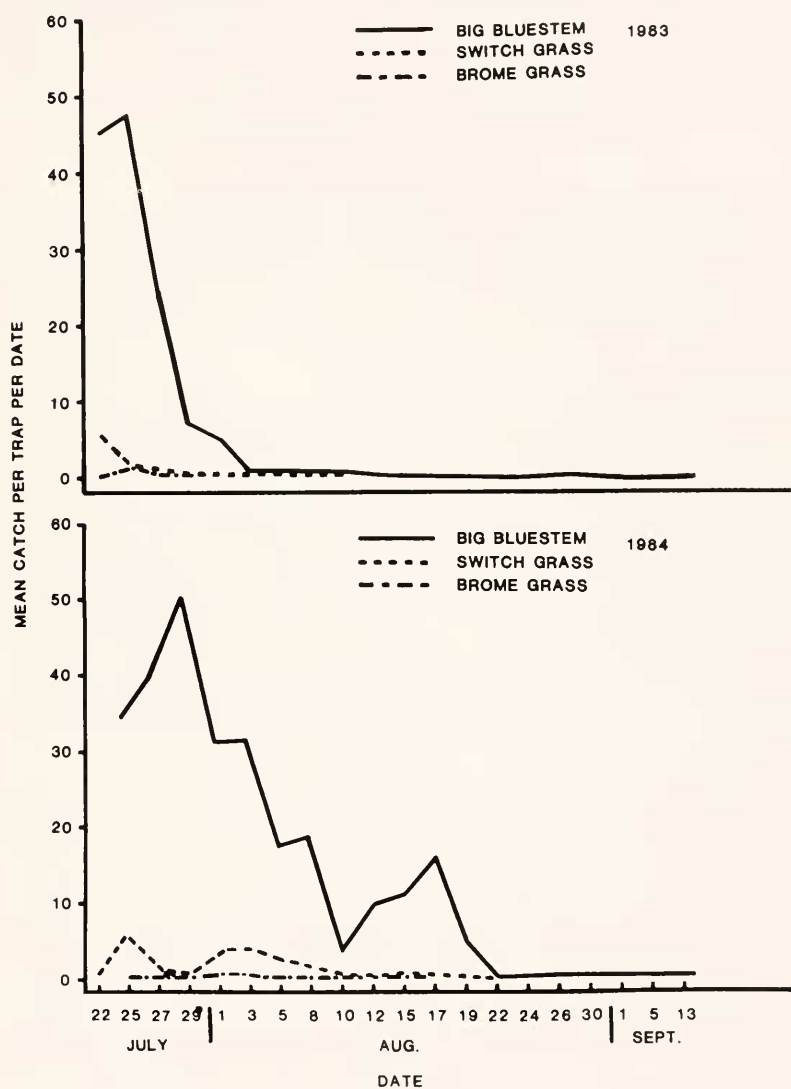


Fig. 1. Mean numbers of *D. cristata* captured on sticky traps placed in plots of three species of grasses during 1983 and 1984.

mechanisms of host plant specificity in this species group. Furthermore, the adults of *Diabrotica* species in general have a predilection to feed on the flowers of cucurbits (Metcalf, 1979); by contrast *D. cristata* and *D. barberi* are unique among *Diabrotica* in that they feed as adults on the flowers of a great variety of prairie forbs (Branson and Krysan, 1981) so comparative studies of these two species would be especially appropriate.

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